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# The acoustics of the Late Prehistoric hypogea of Quinta do Anjo (Palmela, Portugal)

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## Abstract

The hypogea of Quinta do Anjo are constituted by four artificial caves excavated in the soft limestone from Arrabida region, during Late Neolithic, being used as a burial site till the end of the Campaniform Culture. Regarding architecture, they present a flattened top, a sub circular chamber with a dome with central skylight. Two of the hypogea were partially destroyed but the other two (Cave 1 and Cave 2) are well conserved.

In this paper, the authors present the preliminary results of recent field work carried out inside the two preserved artificial caves, regarding the acoustics of these monuments. As a sound source we tested two replicas of clay drums from Late Neolithic, produced in Romania, with the supervision of an expert of experimental archaeology. One of the drums, in beige clay, has a closed bottom being very similar with a drum preserved in the National Museum of Prague. The other, in dark grey clay, has an open base, similar in shape to the original drums of the Copper Age, which were discovered in several locations in Central Europe. It has a deep bass frequency and a strong volume. The first drum has a higher pitch.

Despite examples of these specific drums were not found in the Portuguese territory, pottery drums based on pots with a skin attached may have been used in ceremonies by prehistoric populations, such as burying the dead.

The hypogea chambers of Quinta do Anjo, have maintained their original shape with a small entrance that does not detract from its acoustical properties. We obtained interesting results recording a strong resonance stimulated by the drums, in particular by the open example. The sub circular shape of the domes produces a resonance frequency between 67Hz and 80Hz, which is within the range that can modify the state of human consciousness. In previous researches using electroencephalography, we demonstrated that those same frequencies can alter perceptions of the brain, what can be seen by changes in the prefrontal cortex in the sequence of the mentioned EEG tests. Despite the resonances experienced in these chambers being probably the by-product of architecture, they were certainly noticed by the people that frequented them during the process of burying their dead and placing the offerings of pottery, weapons and other artefacts, since even talking in these hypogea produces some resonance. Nevertheless, recent research of several colleagues is taking in consideration in what extent acoustical phenomena contributed to the design and construction of prehistoric

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sites.

Together with the fieldwork presented here, we also made the same kind of tests on the hypogeum of Alapraia (Cave 1), in the municipality of Cascais, but with less interesting results, since the entrance of the artificial cave was enlarged in the 19th century to create a place for keeping cattle.

**Keywords:** hypogea, acoustics, resonance, clay drums.